



Electron Cloud

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*LARP Collaboration Mtg.
Danford's Inn, April 6-8, 2005*

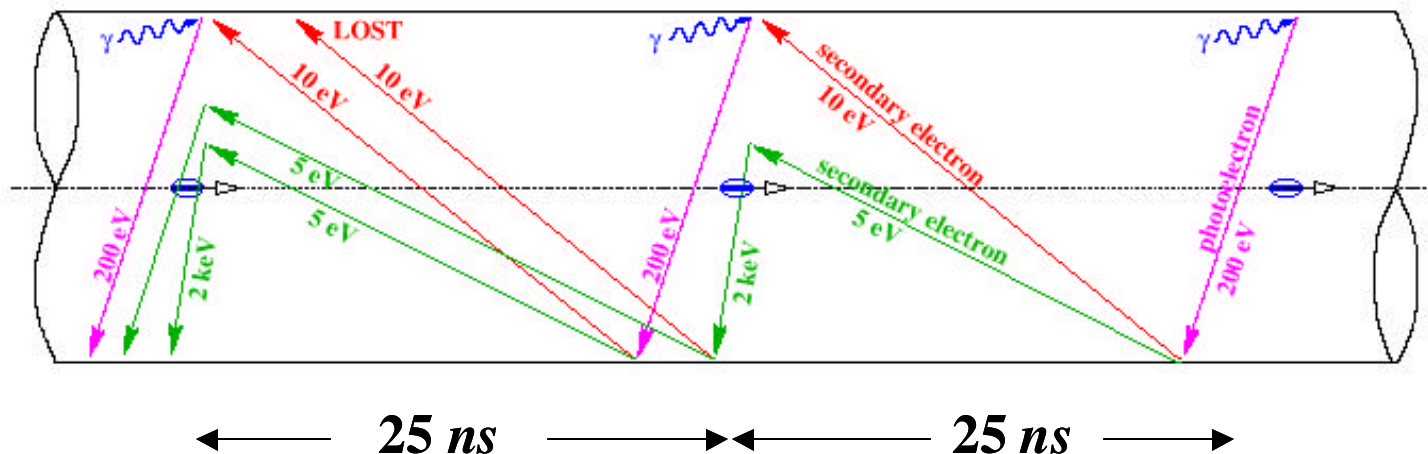


Summary

- E-cloud update
- Goals
- New e-cloud activities at LBNL (not LARP-funded)
 - Details in Jean-Luc Vay's talk (next)
- Proposed additional work

(for strong-strong beam-beam activities at LBNL, see Tanaji Sen's talk)

The electron-cloud effect in LHC



- Beam synchrotron radiation is important
 - provides source of photo-electrons
- Secondary emission yield (SEY) $\delta(E)$ is important
 - characterized by peak value δ_{\max}
 - determines overall e^- density
- e^- reflectivity $\delta(0)$ is important
 - determines survival time of e^-
- Bunch intensity N and beam fill pattern are important
- Main concern: power deposition by electrons



E-cloud-related recent developments

➤ RHIC

- CERN e^- detectors for IP12
 - drawings ready this month
 - to be shipped and installed starting July 2005
 - testing and calibration during 2006 run
 - two dipole magnets, $B \leq 0.2$ T (one detector/dipole)
 - change in design: RT, not cold region
 - vacuum workshop April 11-12 at CERN (R. Hseuh to attend)
- Proposal of ion detector (ionization profile monitor)
 - ionization of residual gas? possible e^- trapping?
- e-cloud maps: paper published PRST-AB (Iriso-Peggs)
- Active search for student or post-doc to replace Ubaldo

➤ CERN

- New analysis of SPS data (D. Schulte & F. Zimmermann):
 - peak SEY $\delta_{\max} \sim 1.4$ and e^- reflectivity $R \sim 0.5$ are good solution to fits
- Cryo pumping available for e-cloud power deposition: $\sim 0.2 \rightarrow \sim 2$ W/m (!)
- Bug in ECLOUD code found and fixed: need $\delta_{\max} < 1.3$ at LHC arcs
 - but SEY model rather simple (eg., no rediffused e^-)
- Earlier large ion density observations at SPS: gone (detector artifact)



E-cloud-related recent developments (contd.)

➤ LBNL

- Participation at HHH2004 (M. Furman, Nov. 2004)
 - discussions on e-cloud codes
 - discussions with W. Herr on beam-beam: basic parameter list for simulations
- Trip to CERN March 21-25, 2005 (M. Furman and Ji Qiang)
 - discussions on e-cloud and str-str-BB
 - feedback from CERN people on our plans
 - status of CERN work
- Summer student has been made an offer
 - to start in May 2005 for 10 weeks
 - total student cost: \$5k
 - possible tasks (TBD): a) simulate LHC power deposition; b) SPS σ_z dependence; c) simulate RHIC e-cloud detectors



Goals

- Progress analyzing June 2004 SPS data (M. Furman and M. Pivi) (0.2 FTE) (*)
 - Especially e^- energy spectrum
 - Goal: constrain SEY model for better predictions for LHC
 - Report due 4/05; paper for PAC05 abstract submitted
 - but we are late (need additional pair of hands)
- Further SPS studies: σ_z dependence (0.1-0.2 FTE)
 - “confusing” lack of correlation between simulations and observations
- LHC heat-load estimate: POSINST-ECLOUD benchmarking (0.2 FTE) (*)
- Report first cut at defining optimal LHC conditioning scenario (0.2 FTE) (*)
 - Define optimal fill pattern during first two (?) years of LHC beam
- Report on applicability of maps to LHC (0.4 FTE) (*)
 - Understand physics of map simulation technique
 - Understand global e-cloud parameter space, phase transitions
- Report on e-cloud simulations for RHIC detectors (0.4 FTE) (**)
 - Calibrate code
 - Then predict BBB tune shift
- Report on e-cloud simulations for LHC IR4 “pilot diagnostic bench” (0.5 FTE)
 - Have some idea what to expect when high-N beam turns on

(*) strongly endorsed by CERN AP group (see H. Schmickler’s talk)

(**) strongly endorsed by CERN vacuum group (J. Miguel Jiménez)



New e-cloud work at LBNL (non-LARP)

- Supported by LDRD (coordinated LBNL-LLNL) since Oct. '02
 - ~\$120k/yr (LBNL) + ~\$180k/yr (LLNL)
 - FY05 is 3rd (and last) year
 - integrated program (simulation, diagnostics and measurements)
 - produce a 3D self-consistent code (“WARP/POSINST”)
 - based on code “WARP” (self-consistent, parallel, MAD input,...)
 - add POSINST e^- emission models, gas, ionization,..
 - arguably state-of-the art
 - centered around the HCX driver for HIF at LBNL
 - $E=1.8$ MeV K^+ ions, ~10-m long machine
 - detectors: electrons, gas, ions at the wall
 - HCX can be simulated end-to-end!
 - main goals:
 - measure various quantities (e^- and gas yields, ion-wall scattering,...)
 - validate code and understand EC details via comparisons against expts
 - ultimately: predictive simulation tool of general applicability

➤ Full details: Jean-Luc Vay's talk (next)



Menu of additional goals

1. Apply WARP/POSINST to **LHC arcs (*)** (~2 years at 0.75 FTE/year)
3-D self-consistent studies (beam, e-clouds, lattice, realistic pipe, photo-electrons, secondaries, gas, ...)
 - start with 1 bunch in 1 FODO cell (in progress); then short trains/multiple cells
 - various bunch spacings and intensities, surface modifications, SEY, ...
 - reduced models: 'POSINST' mode for electrons, 'HEADTAIL/QUICKPIC' mode for beams
 - push toward longer systems: 2-D/3-D WARP/POSINST with maps (**longer term**)
2. Seek understanding of **SPS long e⁻ survival (0.75 FTE+\$25K hardware)**
 - HCX exp'ts can measure e- lifetime in quads
 - modeling will build on our Magnetic Fusion experience
3. Detailed validation of code: comparison with other codes and exp't (**0.5FTE est.**)
4. Model **microwave transmission** through beam tube (SPS, PEP-II) (**0.2FTE**)

(*) strongly endorsed by CERN AP group



Menu of additional goals (contd.)

1. Measure **gas desorbed** by beam (**1FTE+\$20K supplies**)
 - species
 - desorption coefficient
 - distribution $f(v,q)$ (near grazing incidence)
2. Measure gas desorption coef's from **NEG coatings** (**0.5FTE+\$10K supplies**)
 - image direct gas desorption unperturbed by NEG's pumping
3. Extend above to **cryo surfaces** (**1.25FTE+\$250K supplies**)
 - Would require a UHV addition to the present high-vacuum HCX, probably isolating the UHV tank with 4 or more UHV magnetic quads.
4. Simulate ECE **multipactoring** by driving electrodes with **rf** (**0.5FTE+\$20K supplies**)
 - near the electron bounce frequency in a long (5 μ s) beam pulse, with a beam potential of up to 2 kV.
 - RF voltage low enough to pump-out electrons. RF voltage higher to build up e-.



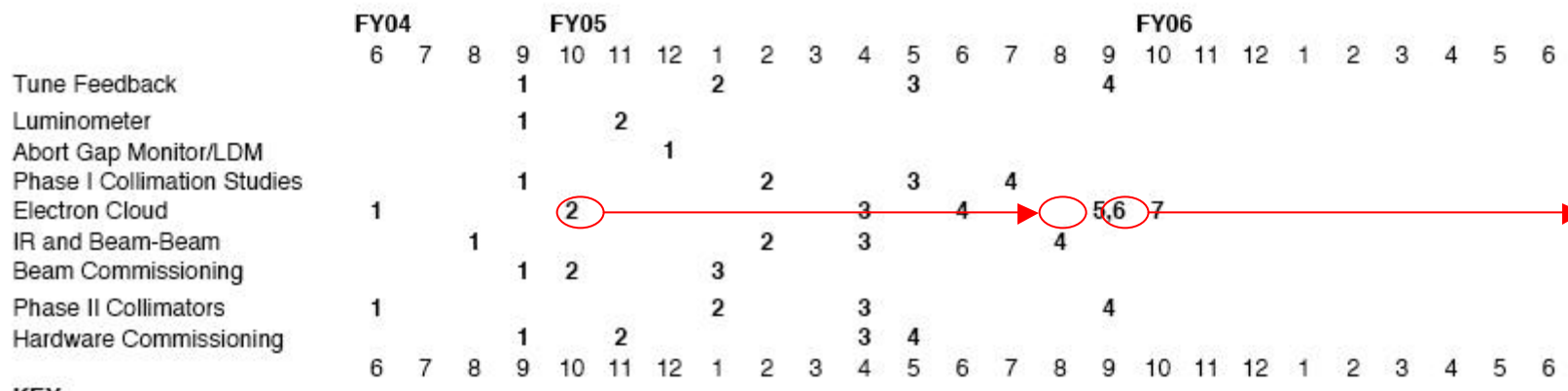
Additional material



EC schedule (Napa LARP Oct. 04)

Accelerator Systems Milestones

June 14, 2004



Electron Cloud

- 1) Participate in SPS EC experiments and studies (when?)
- 2) Install cold EC detector in RHIC
- 3) Report on simulated reproduction of measured spectrum & spatial distribution of SPS ECs
- 4) Report first cut at defining optimal LHC conditioning scenario
- 5) Report on applicability of map simulation technique to LHC
- 6) Report on cold EC in RHIC
- 7) Report on simulated EC at IR4 diagnostic bench